

Large-scale three-dimensional microstructures based on macroporous silicon

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Three-dimensional (3D) nano- and microstructures have been fabricated up to now by using mainly colloidal self-assembly and the so-called *layer-by-layer technique*, i.e. the structure is grown by depositing and patterning successive layers, or bonding various single-layer structures together. Another approach of creating perfect 3D microstructures

is the formation of macropores in silicon by electrochemical etching. In this work we report on the fabrication of 3D microstructures, which are possible candidates for applications as 3D photonic crystals. In the photo-electrochemical etching, macropores of an arbitrary pattern can be formed by lithographically pre-structuring of silicon. The resulting structure is a 2D lattice of well-ordered macropores. The pore diameter is mainly determined by the applied etching current, which itself is adjusted by the backside illumination intensity. In this way, the periodicity parallel to the pore axis (third dimension) can be independently controlled

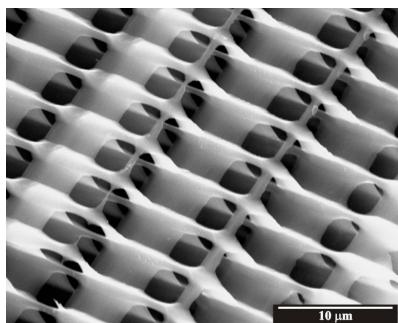


Fig.1. A fully 3D network of interconnected voids in silicon

from the periodicity perpendicular to it. This gives us a freedom to choose the current profile and thus, to modulate the pore diameter accordingly. We have fabricated structures with symmetric and asymmetric variation of pore diameter in depth. We show that with a little additional work the fabricated microstructures can be converted into fully 3D networks of interconnected voids (Fig. 1). The current can be controlled in such a way that different plane defects can be integrated in the structure. These defects could act as planar waveguides or resonator structures.